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ABSTRACT

While distance education can be traced to correspondence courses that in the 19th and 20th centuries relied on mail services to transmit communications between student and teacher, it is the advent of computers networked via the Internet that has dramatically affected the character of distance education. For the purposes of this paper, distance education is defined as occurring when educational experiences are delivered to remote locations via audio, video (live or prerecorded), or computer technologies (synchronous or asynchronous). Discussion includes: technology milestones in distance education from the one-way communication systems relied upon during the first half of the 20th century to the personal computer linked through the Internet; research efforts on the effectiveness of distance education; and the technology infrastructure in United States public schools. To determine electronic instructional resources supported by the National Institute for Environmental Health Science (NIEHS), a review was conducted of curriculum materials available at the NIEHS Web site under the menu listing, Teacher Support. These resources, highlighted in this paper, represent a sample of environmental science materials that have been developed for K-12 learners. (Contains 11 references.) (AEF)

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Distance Education and Technology in the Classroom

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Although distance education can be traced to correspondence courses that in the 19th and 20th centuries relied on mail services to transmit communications between the student and the teacher, the advent of computers networked via the Internet has dramatically affected the character of distance education. For the purpose of this discussion, distance education occurs when educational experiences are delivered to remote locations via audio, video (live or prerecorded) or computer technologies (synchronous or asynchronous) (USDOE,1999A).

Reasons given for the interest in distance education programs by universities and colleges include increasing the enrollment of nontraditional students, and reducing the cost of education for these students. Given these institutional needs, it has been suggested that student benefits for participating in distance education relate to **access**. Conventional wisdom indicates that distance education should provide post-secondary educational opportunities to increasing numbers of students who would not otherwise consider a collegiate experience due to geography, time, family responsibilities, job and or funds (Sherron & Boettcher, 1997). Unfortunately, research evidence on the impact of distance education on access, enrollments and program costs are inconclusive (Gladieux & Swail, 1999). It is evident from the recent survey of distance education undertaken by the National Center for Education Statistics that distance education is becoming an increasingly prominent feature of post-secondary education in the United States. In 1998-99, over 54,000 different distance education courses were offered that provided over 1.3 million enrollments. The technology of choice for providing these courses were two-way interactive video (54%) or Internet courses using asynchronous computer based instruction (58%) or one way pre-recorded video (47%). One way live video (6%), two-way audio transmission (6%) and CDs (6%) were used far less often. In terms of costs, the survey reported that 57% of institutions surveyed are charging comparable tuition and fees for distance education and on-campus courses (USDOE, 1999A).

Technology Milestones in Distance Education

One-way communication systems, such as, print, radio, and television were the distance education technologies relied upon during the first half of the 20th century. These resources were used to transfer information from the teacher to the student. In addition, radio and television broadcasts were dependent on scheduled times that required the student to be listening or watching at particular times. A significant milestone occurred when VCR and cable television were introduced enabling videotapes to be made that could be broadcast at multiple times over the cable channel or sent directly to the student for viewing on their home equipment at any time. In the 1980s, another technological milestone occurred for distance education with the introduction of the personal computer and two-way videoconferencing systems. The two-way videoconferencing systems

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permitted interaction among students and between students and the teacher, while the personal computer opened up a variety of multimedia electronic resources that were provided by CDs. However, the culminating technological advance for distance education occurred when the personal computer was linked through the Internet with e-mail, and world wide web software (USDOE, 1999A).

Effectiveness of Distance Education

Typically, research efforts on the effectiveness of distance education have examined the performance, attitudes, and satisfaction of distance education students with those of on-campus students attending traditional classes. Findings typically reveal no significant differences between student performance in distance education and traditional courses while attitudes and satisfaction of distance education students are generally positive toward their distance experiences. Instructional design specialists contend that when different media treatments provide the same content, performance differences usually do not occur due to the common attributes that the treatments share. Most technologies are multifunctional and can be widely adapted. The synergistic effects of these technologies are ordinarily not examined in a media experiment. Thus, simply changing the delivery mechanism without changing the design of the instructional system will result in no statistically significant differences for that media comparison (Phipps & Merisotis, 1999).

Another line of research in distance education has examined the characteristics of students succeeding with distance education experiences. In their review, Phipps and Merisotis (1999) profile successful distance education students as abstract thinkers who are intrinsically motivated and are directed by an internal locus of control. These characteristics are nearly identical to the profile of students who were found to succeed at individualized, self-paced instruction nearly four decades ago.

Anecdotal evidence that the author gathered from providing an asynchronous Internet course on instructional design twice over two years provides additional insights about the effectiveness of distance education courses. During the initial year, students with substantial technology skills enrolled in the course and proceeded through the course on schedule with all students completing the required experiences and assignments on time. During the second year, a number of students with very limited technology skills and limited access to Internet linked computers enrolled in the course. Many challenges occurred with a number of students being unable to log onto the network and communicate via intranet e-mail. These limitations resulted in 12% of the individuals enrolling in the course either dropping or failing the course, and 38% of the class members that remained in the course being granted incomplete grades in order to complete the requirements for the course. These experiences with essentially the same course materials and course support system (WebCT) resulted in quite different experiences for the students enrolled in this course and the course instructor. As a result of the second year experience, a prospective student must pass a computer performance test as a prerequisite for enrolling in this distance education course. This test includes accessing world wide web resources and attaching documents to e-mail messages.

Technology Infrastructure in Public Schools

The telecommunications infrastructure in public schools across the United States has changed significantly across the past five years. Financial support for technology integration in schools has been substantial, resulting in dramatic changes in classroom connectivity and classroom technology equipment. Recent national reports indicate classroom connectivity to the Internet soared from 14% in 1996 to 63% in 1999 (USDOE, 2000; Web-based Education Commission, 2000). This growth is due in part to the E-Rate (Education rate) program that began in 1998. This program was established by the Telecommunications Act of 1996 to aid schools and libraries in making technologies and telecommunication services available at discounted rates (USDOE, 1999B). In Texas, the level of connectivity recorded in 1996 for classrooms was modest with over 70% of the districts reporting **no** classroom access to the Internet, while in 2000 over 96% of classrooms have Internet access (Denton, Davis & Strader, 2001). The dramatic changes in connectivity in Texas public schools have been influenced by high levels of participation by schools in the E-Rate program and 2300 telecommunications grants from the Telecommunications Infrastructure Fund Board (TIF website, 2001).

Another indicator of technology infusion into school classrooms is the ratio of students to computers with Internet access. Interestingly, in 1998, rural schools across the United States had a lower ratio of students per Internet accessible computer of 9:1 than city schools with a ratio of 14:1 (USDOE, 1999B). For Texas, today's classroom holds two networked computers (Denton, Davis & Strader, 2001). This number corresponds to the student to computer ratio of 8.9:1 value reported for 1999 in the Texas Education Agency's *Progress Report on the Long-range Plan for Technology, 1996-2010* (December, 2000), and the national average of 9 to 1 (Web-based Education Commission, 2000). While these values are consistent with one another, a substantial gap exists between the current ratio and the recommended student to computer with Internet access ratio of 3:1 in the *Long Range Plan for Technology, 1996-2010* (TEA, 1996).

The report, *Teachers' Tools for the 21st Century: A Report on Teachers' Use of Technology* (USDOE, 2000) includes a finding that approximately one-third of the teachers questioned in a national survey reported they are well prepared to use computers and the Internet for classroom instruction. In Texas, district technology coordinators estimate that 37% of their teachers use workstations for routine activities and e-mail and another 24% of the teachers are beginning to use the Internet for instruction. This is encouraging information, but much still needs to be accomplished, because just 18% of the teachers use on-line resources in their instruction (Denton, Davis & Strader, 2001).

Distance Education Environmental Resources

In an effort to determine electronic instructional resources supported by the National Institute for Environmental Health Science, a review was conducted of curriculum materials available at the NIEHS web-site, http://www.niehs.nih.gov/ under the menu listing, Teacher Support. These resources represent a sample of environmental science

materials that have been developed for K-12 learners and can be accessed in a variety of ways.

Resources for Demonstrations to be presented in schools

Wayne State University, NIEHS Center for Molecular and Cellular Toxicology

- Where are the Chemicals? - This lesson is designed for grades K-2.
- Plants and Pollution – This lesson plan consists of 4 lessons for grades 3 through 5.
- Get the Lead Out - This Lesson is designed for grades 6 and above.

Print Resources and Professional Development Support

My Health My World Project at Baylor College of Medicine - The award-winning My Health My World project has developed four sets of exciting educational materials on current environmental issues for students in grades K-4. The print resources are supported by a web-site, professional development experiences, and 12 Radio Healthline stories per year (one each month) on environmental health issues. The audio files can be downloaded with RealPlayer G2 at the URL, http://www.myhealthmyworld.org/main.html

National Eye Institute, NIH: http://www.nei.nih.gov/publications/schintro.htm This site offers information and ordering instructions for free materials for, "Vision -- Program for Grades 4-8".

On-line Resources

Maryland Public Television and Johns Hopkins School of Hygiene and Public Health's EnviroHealth Link Website for 5th through 9th grade students

- "The Case of the Disappearing Frogs" webpage provides an environmental science project.
- Classroom Central webpage provides access to technology-infused, standards-based lesson plans on environmental health topics of Air Pollution, Cancer, Food, Lead Poisoning, Noise Pollution, Water Pollution/Pfiesteria, and Radiation.

Project Greenskate - Project Greenskate was developed by the HERE@UW Program at the University of Washington - http://depts.washington.edu/hereuw/gs.html In this web-based resource, students investigate the potential health concerns surrounding the hypothetical development of a city park on a former industrial site contaminated with certain common environmental pollutants (lead, PCB, and TPH). In addition to designing educational materials, this program offers workshops for educators, lead lab tours for school groups, and work on school to work and occupational safety and health issues for working teens.

On-line curricula

Toxicology Risk Assessment and Pollution (ToxRAP) - This K-9 curriculum, developed by the Resource Center at the Environmental and Occupational Health Sciences Institute (EOHSI) at the University of Arizona, is an innovative curriculum that introduces students to the principles of toxicology and the process of risk assessment. On-line activities and pdf format Teacher Guides and Student Worksheets are available at http://swehsc.pharmacy.arizona.edu/coep/exercises.html

The Biology Project - The worldwide web is the ultimate form of outreach, and the primary domain of The Biology Project, an online interactive resource developed by the University of Arizona. To take the on-line class, visit their website, http://www.biology.arizona.edu/

The PEER projects at Texas A&M University

The Partnership for Environmental Education and Rural Health program (PEER) is a collaborative effort among faculty and staff of the College of Veterinary Medicine, the Center for Environmental and Rural Health (CEHR), the eEducation Group in the College of Education from Texas A&M University and the Texas Rural Systemic Initiative (TRSI) located at West Texas A&M University. The goals of this collaborative effort are to increase the number of rural public school students who enter and remain in academic science tracks and improve their overall academic performance.

Strategies to accomplish these goals include:

- Scientist visits to classrooms - Over 4,200 students and 600 teachers have received scientist visits across 30 different rural schools.
- Development of web-based curricula - Three different web-based curricular modules (Water's the Matter, Cells Are Us, and Toxic or Not) each containing 5 units have been prepared and are currently undergoing field-testing with more than 1,200 middle school students. These curricular resources are available at http://peer.tamu.edu/. New modules, (Organ systems, and Toxic Hazards) are under development.
- Engaging interdisciplinary environmental science materials are being developed that will be used in science, mathematics, social studies and English classes of rural students in grades 6-8. These resources will be distributed as CDs and print documents.
- Five day professional development Intensive for science teachers - This hands-on experience provides teachers with timely environmental health science content and laboratory exercises and instructional technology design and application activities. The initial summer Intensive was held in July 2000 with 15 teachers participating in the experience. A second Intensive is being planned for June 2001 for 20 science teachers.
- Regional Water Quality workshops – These data gathering experiences were conducted at rivers or streams with 64 teachers during year 1. Teachers from

participating schools receive a water testing kit to use with their classes. Four water quality workshops are scheduled for the summer months for year 2.

- Curriculum Integration workshops – Five summer workshops are scheduled for teams of teachers to explore processes for implementing the interdisciplinary materials that will be provided in print and on a CD.

It is too soon to judge whether the PEER programs are increasing the number of rural public school students who enter and remain in academic science tracks and whether they improve their overall academic performance. The multiple strategies of directly interacting with school learners via the scientist visits, and providing professional development opportunities for their teachers with the Water Quality workshops, Integration workshops, Summer Intensives, the online Environmental Health Science curricular resources and interdisciplinary electronic resources are addressing the PEER goals from different perspectives. The PEER strategy of targeting different audiences in the school community complements the goals of the Texas Rural Systemic Initiative project supported by NSF, that encourages systemic change of the entire school organization.

Distance Education Horizon

At the beginning of this paper a brief account of distance education technologies was presented ranging from printed material delivered by mail services to video-conferencing systems and on-line interactive resources. The near future is now being shaped by Internet 2 and the creation of meta-data standards to manage, organize and catalogue digital information for researchers, teachers and students. Large state-wide education networks that already exist in a handful of states will expand enabling increased access of digital libraries to public school teachers and their students. Access to a broad array of resources (print to multimedia) through very robust telecommunication networks on the horizon suggests the development of electronic resources and professional development experiences for using these resources will enable and extend the near future trends for distance education.

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